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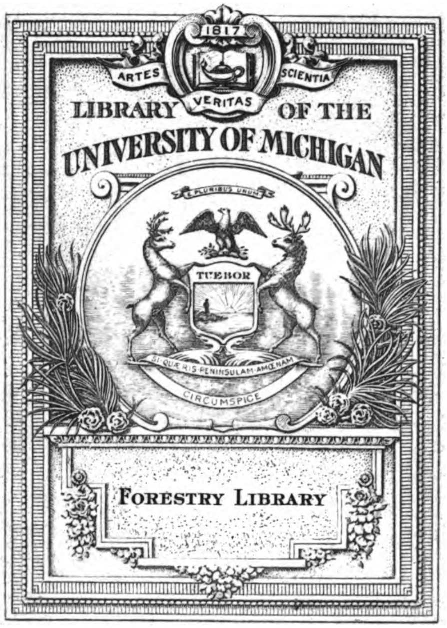

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MISCELLANEOUS PAPERS.

The Grafted Papaya as an Annual Fruit Tree . . . . DAVID FAIRCHILD and EDWARD SIMMONDS
The Work of the Belle Fourche Experiment Farm in 1912 . . . . . BEYER AUNE
A Hand Grain Thrasher . . . . L. J. BRIGGS
Arabian Alfalfa . . . . ROLAND McKEE

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THE GRAFTED PAPAYA AS AN ANNUAL FRUIT TREE.[1]

By **David Fairchild**, *Agricultural Explorer in Charge of Foreign Seed and Plant Introduction*, and **Edward Simmonds**, *Superintendent in Charge of the Subtropical Plant Introduction Field Station.*

INTRODUCTION.

It is doubtful whether there is any fruit tree in the world that grows as rapidly as the papaya (*Carica papaya*) or that yields as heavily in so short a time, and it is hard to understand how this tree, with so many interesting characteristics, should have remained for centuries in the primitive horticultural position of a seedling tree crop.

One of the writers, Mr. Simmonds, has successfully grafted the papaya, and as this discovery places the fruit on a new basis it is worth while to consider it from a new point of view.

There is probably no better known fruit tree in the Tropics than the papaya, which is now well distributed throughout the frostless regions of the globe. It was probably taken to the Orient from its native home in South America shortly after Columbus discovered America, for it is described and figured as early as 1656 [2] as an Indian plant which was being introduced into China. The tree is now cultivated or grows wild in almost every part of the Tropics, and the number of papaya fruits consumed by tropical peoples must be extremely large.[3]

Almost every traveler in southern countries is struck by the remarkable way in which the fruits of this papaya are borne, clustered close to the single unbranched stem near its top, and also by the accounts of the peculiar property which the leaves of the papaya have to digest fresh or cooked meats or to render tough meat tender merely by wrapping them around it. The discovery that this phenomenon is caused by the presence of papain, or papayotin, in its milky juice and that this papain when properly prepared has distinct value as a medicine [4] has added new interest to the plant and led to its cultivation by the peasants of Montserrat and latterly by the Singhalese[1] of Ceylon, who gathered the juice for papain manufacture.

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[1] Issued Mar. 29, 1913.

[2] Boym, Michael. Flora Sinensis, 1656, pl. A. Cited in Watt, Sir George, The Commercial Products of India, London, 1908, p. 269.

[3] Kawakami, Takiya. A List of Plants of Formosa, Taihoku, 1910, p. 43.
Willis, J. C. Agriculture in the Tropics, Cambridge, 1909, p. 95.
Watt, Sir George, Op. cit., p. 270.

[4] Pardo de Tavera, T. H. The Medicinal Plants of the Philippines, Philadelphia, 1901, p. 123.
Chittenden, R. H. Papoid-digestion. Transactions, Connecticut Academy of Arts and Sciences, v. 9, p. 298-332, 1892.
Kilmer, F. B. The story of the paw-paw. American Journal of Pharmacy, v. 73, p. 272-285, 336-348, 383-395, 1901. Abstracts in Pharmaceutische Zeitung, Jahrg. 46, p. 561-562 and 629, 1901.

THE PAPAYA HERETOFORE PROPAGATED FROM SEED.

Notwithstanding the remarkable productivity of the papaya, that its fruit is a delicate, wholesome, delicious food for which there is a constant demand, and that it probably is the most precocious of any of the tropical or subtropical fruit trees, it seems to have been always propagated from seed wherever it has been grown in the Tropics; and this, too, despite the fact that the species is diœcious as a rule, producing the male and female flowers on different plants, and the character of the seedlings is often so variable that out of a hundred seeds planted, all coming from the same fruit of good quality, not over two or three will produce as good fruit as the one from which the seeds came. More than half of the seedlings may be males and of the remainder most of them may be of poor quality. Notwithstanding these facts, which would seem to have made it almost imperative that an asexual method of propagation be devised, tropical horticulturists seem to have looked upon it up to the present time as a plant which could only be grown from seed. The greenhouse gardeners, on the other hand, who have grown the plant for experimental purposes, seem to have discovered that the species was easily grown from cuttings, for we find in Johnson's Gardener's Dictionary, London, 1905, page 176, for example, that the papayas are classed as "stove" evergreen trees which can be propagated by means of "cuttings of ripe shoots in sandy soil under a bell glass and in sweet bottom heat; rich, loamy soil." In Bailey's Cyclopædia of American Horticulture, volume 1, 1910, page 245, there appears a note written by Mr. E. N. Reasoner to the effect that "sometimes small branches form, and these may be cut off and as readily rooted as most tropical decorative plants, providing the cutting is not too young and tender." It seems rather remarkable, in view of such statements as these in standard works on horticulture, that Macmillan,[2] of Ceylon, should make no mention of an asexual method of reproduction, that Kilmer, in his remarkable story of the "paw-paw," published in 1901,[3] should dismiss the question of a rational propagation of the tree with the remark that "methods of artificial fertilization and budding, such as is found in the propagation of lemons and oranges, are now in the experimental stage,"[4] and that Higgins should make the statement that "it will be understood that there is no means available for the propagation of the papaya by asexual parts, as cuttings, buds, scions, etc. Hence, seed varieties must be established by methods probably similar to those used in breeding varieties of vegetables and flowers which are not propagated by budding and grafting."[1]

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[1] Willis, J. C. Agriculture in the Tropics, Cambridge, 1909, p. 95.

[2] Macmillan, H. F. A Handbook of Tropical Gardening and Planting, Colombo, Ceylon, 1910, 524 p., illus.

[3] Kilmer, F. B. The story of the paw-paw. American Journal of Pharmacy, v. 73, p. 272–285, 336–348, 383–395, 1901.

[4] Kilmer, F. B. Op. cit., p. 285.

Nothing, perhaps, illustrates better the untouched possibilities of scientific plant propagation in the Tropics than the discovery of the method of grafting the papaya which is described in this paper.

THE PAPAYA GROWN FROM CUTTINGS.

To Mr. Aston W. Gardner, of Kingston, Jamaica, we owe the suggestion which has led directly to the investigation of methods for the propagation of the papaya. In a letter written by him on May 30, 1912, he called attention to the fact that he had on his place near Kingston papayas which he had grown from cuttings, and at the suggestion of one of the writers he sent to the Office of Foreign Seed and Plant Introduction a cutting, together with a photograph of trees which he had successfully grown in this way from seed of a good fruit imported by him from Hawaii. It was this practically successful demonstration which encouraged us to make a more thorough investigation of the whole situation, with the result that successful grafts have been made and are now growing at the Miami (Fla.) Subtropical Plant Introduction Field Station.

While it proved an easy matter to grow the cuttings of the papaya, the process turned out to be so slow as to be of little value for conditions prevailing in southern Florida, where it is of the utmost importance to grow and fruit papayas and get them off the ground within 15 months. The grafting of the papaya, on the other hand, has proved to be eminently suited to these conditions, and it is believed will prove superior even in the Tropics to the method of growing the plant from cuttings.

The bearing of this discovery on this neglected tree crop is well worthy of the consideration of all whose fruit lands are below the region of annual freezes, and it is even possible that the fact may prove to be of interest to those whose operations are in regions like southern Texas, where the temperature goes below freezing every winter.

Heretofore the difficulties surrounding the cultivation of the papaya have been very great; that is, when viewed from the modern standpoint of fruit culture, which demands uniformity of size, form, color, flavor, and ripening period. No modern horticulturist would think of planting a seedling apple orchard, although all of the fruit trees might bear apples. He would probably be unbearably ridiculed, however, if more than half of the seedlings of the apple were males and he set out an orchard with the full understanding that from 60 to 75 per cent of the trees would have to be cut out as soon as they bore flowers. This, nevertheless, is the condition which up to the present time has been imposed on the cultivator of the papaya.

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[1] Higgins, J. E. Papaya investigations. Hawaii Agricultural Experiment Station Annual Report, 1911, p. 26, 1912.

In experiments which were carried on in Jamaica some years ago, as described by Kilmer,[1] acres of ground were planted with thousands of papaya plants in which the males predominated in the ratio of over 15 to 1.

In an experiment carried on at the Subtropical Plant Introduction Field Station last year, out of 60 plants 60 per cent were males and only one tree is producing fruit of a size and quality closely similar to the fruit from which the seed was taken. From a modern horticultural standpoint, in other words, a small orchard of 60 trees was set out and only one good tree secured.

VARIETIES CROSSED WITH WILD MALES.

This condition of extreme variability has doubtless been increased by the fact that almost everywhere in the Tropics there are wild seedlings whose abundant pollen is carried by insects to any near-by plantations of good varieties and being, perhaps, prepotent, fertilizes quite generally the female flowers of the good varieties. It is a striking fact that the seeds from a single large-fruited papaya will produce a large proportion of plants which bear small fruits of the wild type. That this condition of variability of the papaya is general throughout the Tropics may be assumed from the extremely varied statements with regard to the edibility of this remarkable fruit.

Mr. A. Smith, in Lindley's Treasury of Botany, 1899, page 224, makes the statement that "the ripe fruit is seldom eaten raw, although with the addition of pepper and sugar it is said to be agreeable." Johnson's Gardener's Dictionary, 1905, page 176, makes the remarkable statement that "the papaw fruit (*Carica papaya*) is eaten, when cooked, in some parts of South America, but not much esteemed by Europeans." Watt, speaking of East India conditions, states [2] that "the ripe fruit is eaten by all classes and esteemed innocent and wholesome. In some localities, such as Hazaribagh in Chota, Nagpur and Gauhatti in Assam, the fruit is large and very sweet; in others it is small, coarse, and hardly edible."

The opinion generally prevails that to obtain good fruit it is necessary to remove a majority of the male trees. In other words, although the papaya is perhaps as old a cultivated plant as the date palm, and although it is also diœcious, the inhabitants of tropical countries have not learned to propagate the good varieties asexually, as the Arabs have the date palm.

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[1] Kilmer, F. B. Op. cit., p. 285.

[2] Watt, Sir George. Op. cit., p. 270.

POSSIBILITIES OF THE GRAFTED PAPAYA.

With the discovery, therefore, of a practical method of rapid asexual propagation, the papaya enters upon a new era of possibility. That this is a possibility may be judged from the observations which have been made during recent years by one of the writers, particularly in southern Florida. It is found there, for example, that seeds of the papaya, when planted in the greenhouse in February, produce young seedlings large enough to graft some time in March; that these grafted trees, which can be grown in pots, when set out in the open ground in May or the latter part of April, make an astonishing growth and come into bearing in November or December; that they continue bearing throughout the following spring and summer, and, if it is advisable, can be left to bear fruit into the following autumn.

A single March-budded plant will bear from two to three dozen fruits during the following winter and spring, and these fruits will average from 2 to 3 pounds apiece, so that a single papaya tree should yield 48 to 72 pounds of fruit within 15 months. It has been found, however, that the papaya is a plant peculiarly subject to root-knot, caused by a species of nematode, and it is therefore important that it be handled as an annual tree crop and be not planted year after year on the same ground, but in rotation with other crops.

The papaya is a gross feeder, producing a root system composed of large soft-wooded roots which anchor it firmly to the ground. It is not particular as to soil. It will grow on a manure heap or on rocky coquina soil, on sandy land or in rich clay loam—in any place where its large roots can get a foothold. In clearings in a hammock, for example, it is one of the first plants to make its appearance, and it is remarkable how commonly the wild papaya fills a clearing through the hammock in southern Florida.

It would seem to be an ideal plant for a small grower for home use, as it can be fed liberally with manure and has the nature of a dwarf tree. The fact that the fruits are clustered around the main stem in the axils of the leaves would suggest the possibility of easily protecting them from birds, insects, and perhaps from frost injury.

The fruits when ripe are of a golden-yellow color and when they are cut open somewhat resemble a yellow cantaloupe, although the color of the interior is a deeper orange. The dark-brown seeds are as easily removed as the seeds of a cantaloupe. There is less fiber to the papaya than the muskmelon, and the fruit flesh is more melting in character. It has a characteristic flavor and odor of its own, which varies greatly. The milder flavored varieties are generally preferred by those who are not familiar with the papaya, but the richer flavored ones, although they sometimes have an odor objectionable to those unacquainted with them, are generally preferred by people familiar with the papaya.

Since this fruit, however, has been until the present time on a seedling basis, it has been impossible to select strains and keep them pure. From now on it will be possible, it is believed, to select from the host of seedlings which appear in any planting of papayas the forms best suited for shipping and marketing purposes. As the size of these fruits varies from a few ounces to 20 pounds, it is apparent that this work of selection will offer an interesting field for the tropical horticulturist. For shipping purposes, the small-fruited forms will probably be best adapted—those weighing not over a pound and a half apiece; and the more nearly round the shape the more easily the fruits will be packed and, in all probability, the better they will carry to market. While such experiments as have been made in the shipping of the papaya indicate it to be a rather poor shipper, these early experiments were generally made with the large-fruited types. The scanty experience of the writers in shipping papayas indicates that if packed just before the fruits begin to turn yellow, they can be sent to the northern markets and arrive in a marketable condition. Mr. Gardner, of Jamaica, has shipped papayas successfully from Kingston to London. These are questions, however, which were difficult of solution so long as the papaya remained on a seedling basis.

That there will be a growing demand for the papaya is the full conviction of the writers. Fruits of good varieties have sold in Miami locally for several years for fancy prices. As high as 25 cents has often been paid for a single fruit, and Mr. Gardner has sold the fruits in London for 40 cents apiece. Such prices as these can not be expected to prevail after the fruit is put on a commercial basis.

METHOD OF GRAFTING EMPLOYED.

The method of grafting the papaya is so extremely simple that it seems remarkable that it was not discovered earlier. The difficulty evidently lay in the fact that a bearing papaya tree under ordinary circumstances has no bud wood for grafting purposes. After a seedling begins to fruit, it does not normally produce side shoots which can be used for grafting. It has been observed for some time, however, that if the top of a bearing tree is cut or broken off accidentally, a large number of shoots begin to form, one from the upper part of each leaf scar; that is, the axil of the leaf. This takes place three or four weeks after the tree is decapitated. It is these small shoots (fig. 1), of which as many as 50 or more may be produced by a single tree, that are used in grafting the papaya. One of these shoots is taken when a few inches long and about the diameter of a lead pencil, is sharpened to a wedge point, the leaf surface reduced, and inserted in a cleft in a young seedling papaya plant which has been decapitated when 6 to 10 inches high and split with an unusually sharp, thin grafting knife. (Fig. 2.) At this age the trunk of the young seedling has not yet formed the hollow space in the center. It is not necessary for the stock and the scion to be of equal size; the scion should not, however, be larger than the stock. After inserting the scion, the stock is tied firmly, but not tightly, with a short piece of soft twine. The grafted plant should be shaded for a few days after the grafting has been done and the twine should be removed on the sixth or

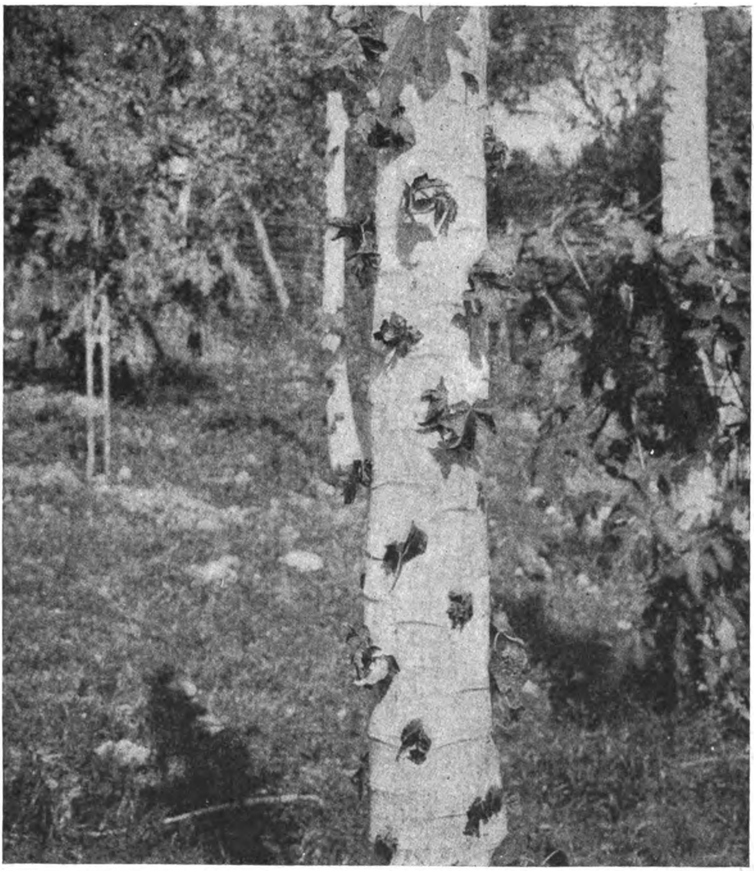

FIG. 1.—Trunk of a papaya tree, showing shoots which arise from the leaf scars. Three or four weeks after a tree is topped these shoots form and may be used for grafting. In the background are two other topped trunks.

seventh day. (Fig. 3.) The best success has been secured in these experiments by grafting potted seedlings in the greenhouse or under the shade of a lath house, presumably because the stock can be kept in good growing condition under these circumstances. Under these conditions fully 75 per cent of successes can be expected. In the field, also, this method has been successfully followed. The tree shown in figure 4 was grafted on June 26, 1912, and, as is apparent, has made a satisfactory growth.

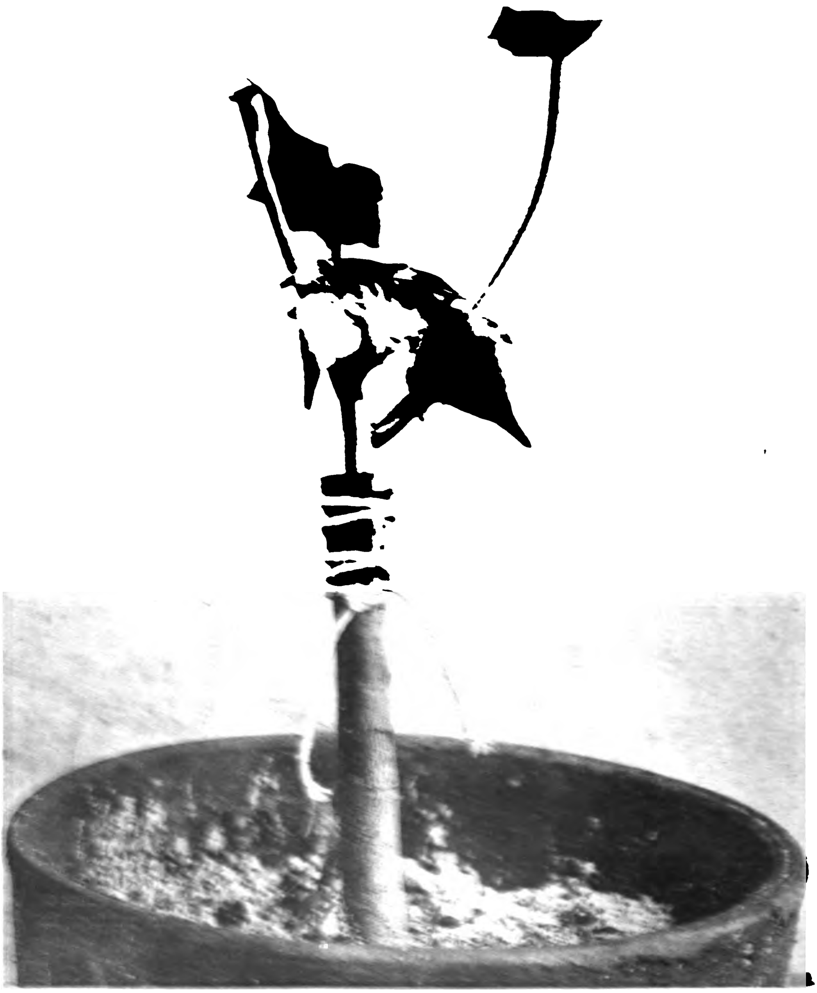

FIG. 2.—A newly made papaya graft. A seedling plant grown in a flat and later potted off has been cut back and split to receive the graft taken from the trunk of a desirable seedling tree. The twine is removed seven days after grafting.

A number of grafted papayas are now being prepared for a somewhat extensive experiment at Miami during the coming season, and as large a stock as possible of several selected seedlings will be provided for experimental planting in May, but the writers wish to point out particularly that as this was the first season it is possible that there may be drawbacks to the development of the papaya

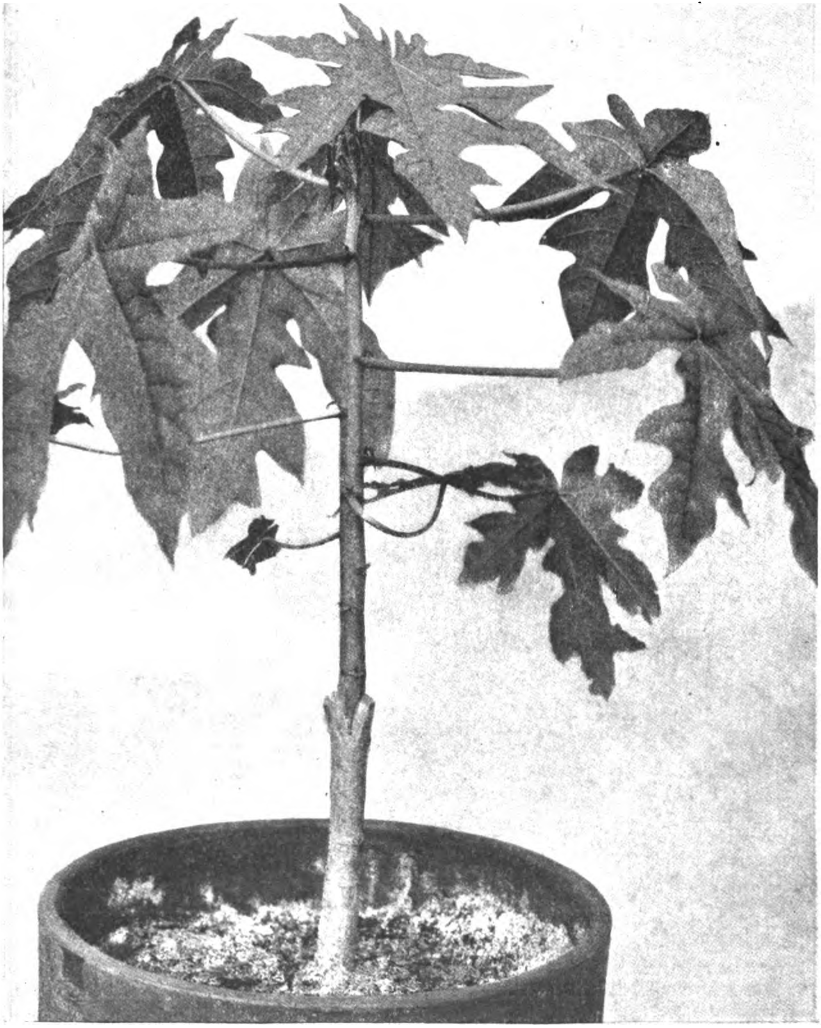

FIG. 3.—A young grafted papaya plant. The union between stock and scion is apparently poor, but a perfect one nevertheless. It makes no difference if the scion is smaller than the stock.

plantations of grafted plants, notwithstanding the fact that all the indications point toward the method of grafting as the logical one upon which to place this remarkable tropical fruit plant.

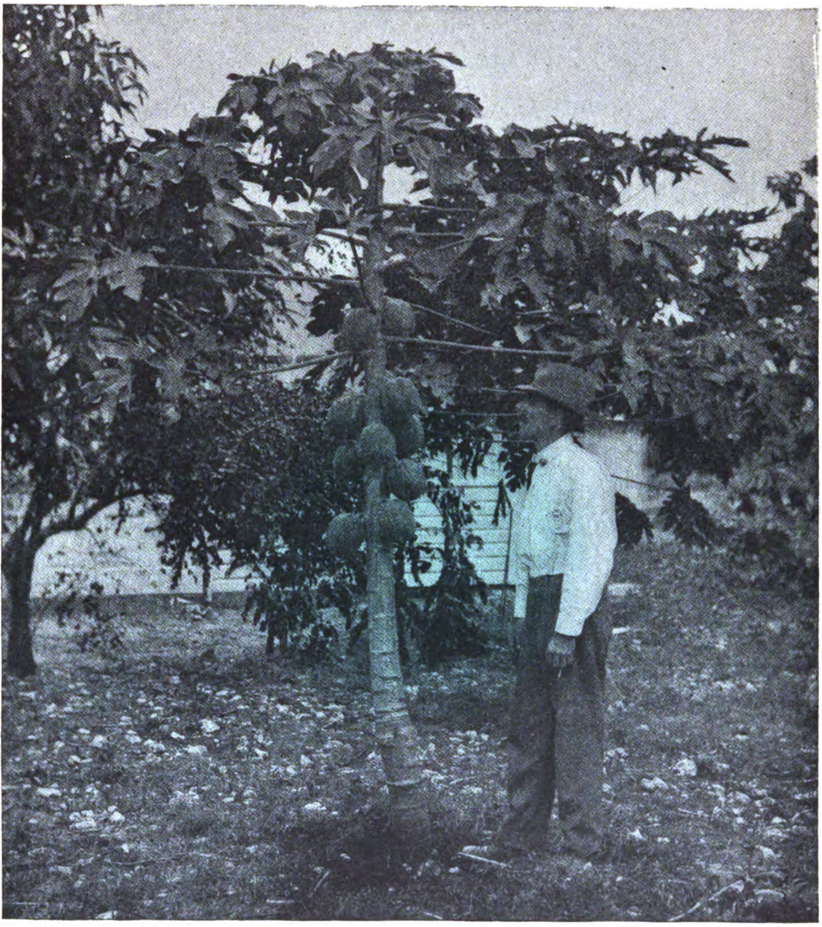

FIG. 4.—A grafted papaya tree. Unusual interest attaches to this tree because it is believed to be the first grafted papaya. Mr. Edward Simmonds, who stands beside it, inserted the graft on June 20, 1912, in a seedling which had sprung up in the Subtropical Plant Introduction Field Station, Miami, Fla.

POSSIBILITIES OF HYBRIDS.

Granting the successful grafting of the papaya, the possibility is suggested that certain close relatives of it may be used as a stock or for breeding purposes in connection with the development of the papaya industry. There seems to be nothing on record to indicate that any attempt has been made to hybridize the different species of Carica in order to produce new varieties or to use them as stocks, although some of these might be decidedly more hardy. *Carica quercifolia* is distinctly hardier than *Carica papaya.* Specimens of it have borne fruit as far north as Chico, Cal. The plants have been killed back to the ground every winter, but have quickly recovered and have borne large quantities of small fruits the size of a small plum. The mountain papaya (*Carica candamarcensis*) of Ecuador, coming from an altitude of 9,000 feet in the Andes, is cultivated quite extensively in the mountains of Ceylon, where occasional frosts have been known to occur. The fruits of this species are quite different from those of *Carica papaya,* being smaller and having a refreshing acid flavor. According to Macmillan,[1] this species was introduced into Ceylon in 1880 and is now commonly grown for the sake of its fruit. It has gone wild about the bungalows in these high altitudes. The fruits are in season all the year round, and though too acid to be used for dessert are very agreeable when stewed, and can also be made into jams and preserves. When ripe, they have a pleasant applelike odor.

It would seem, in conclusion, that this tropical tree crop, like other tropical crops, needs an entire overhauling, and its development as a grafted fruit should be undertaken as soon as possible.

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[1] Macmillan, H. F. Op. cit., p. 173.

THE WORK OF THE BELLE FOURCHE EXPERIMENT FARM IN 1912.[1]

By **Beyer Aune**, *Farm Superintendent, Office of Western Irrigation Agriculture.*

INTRODUCTION.

The work of the Belle Fourche Experiment Farm consists of a large variety of field experiments, both with and without irrigation. From 1907 to 1911 all the experiments were conducted on dry land, but when water was brought to the farm in 1912 experiments under irrigation were inaugurated. The work of the farm includes field tests with grains, forage crops, vegetables, orchard and shade trees, and a number of rotation and tillage experiments. (Fig. 1.)

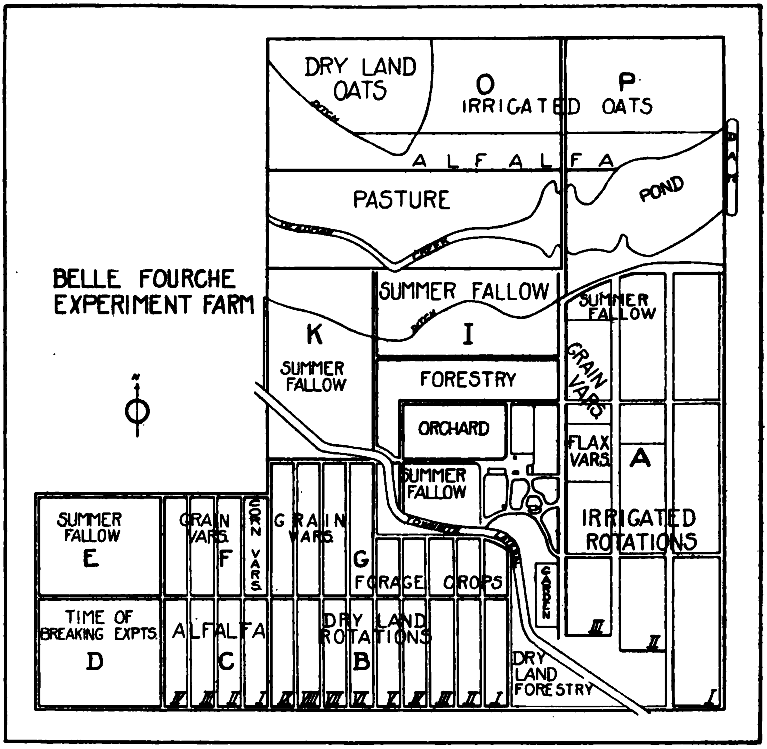

FIG. 1.—Diagram of the Belle Fourche Experiment Farm, showing the arrangement of the fields and the location of the crop experiments in 1912.

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[1] Issued Mar. 29, 1913.

The Belle Fourche Experiment Farm consists of 280 acres of land on the Belle Fourche (S. Dak.) Reclamation Project, of which 160 acres were set aside by Executive order and 120 acres were withdrawn from entry by the Department of the Interior for use as an experiment farm. Operations were commenced in 1907. The farm is operated by the Bureau of Plant Industry, Department of Agriculture, and is in charge of the Office of Western Irrigation Agriculture. A farm superintendent, detailed by that office, has general supervision of the experiments.

COOPERATION.

Much of the work of the experiment farm is done in cooperation with other offices of the Bureau of Plant Industry and with the Forest Service. The nature and extent of this cooperative work is indicated below.

Biophysical Laboratory.—The Biophysical Laboratory cooperates in all the climatological and physical observations. This work includes measurements of rainfall, wind, evaporation, and temperature, and miscellaneous physical observations. A summary of these observations is given in Table I.

Dry-Land Agriculture.—The Office of Dry-Land Agriculture uses about 20 acres, divided into one-tenth-acre plats, for rotation and tillage experiments above the canal. These experiments include continuous cropping by ordinary methods and moisture-conservation methods compared with alternate cropping and summer fallow, a comparison of various three-year rotations, and crop rotations for the conservation of humus. An assistant in Dry-Land Agriculture is detailed for this work.

Cereal Investigations.—This office has charge of the variety testing of grains suited to dry-land conditions and of the plant-breeding work with the most promising varieties of grain. During the year 1912 much time was devoted to methods of planting winter wheat. An assistant detailed by the Office of Cereal Investigations has charge of these experiments. Approximately 20 acres of land are used.

Alkali and Drought-Resistant Plant Investigations.—This office does variety testing and breeding work with forage crops, including alfalfa, brome-grass, western wheat-grass, sorghum, and millet, and conducts studies of the water requirements of the different varieties and strains tested. About 15 acres of land are devoted to the work, and an assistant is detailed to supervise the experiments.

Corn Investigations and Sugar-Plant Investigations.—The offices of Corn Investigations and Sugar-Plant Investigations cooperate in the work with corn and sugar beets, respectively, each office using about 2 acres of land. The tests with these crops include variety testing and tillage experiments.

Forest Service.—The United States Forest Service cooperates in the testing of trees for shade, wood-lot, and windbreak purposes. About 9 acres of land are devoted to this work.

CLIMATIC CONDITIONS.

The climatological observations made during the five years 1908 to 1912, inclusive, are briefly summarized in Table I.

TABLE I.—*Summary of climatological observations at the Belle Fourche Experiment Farm, 1908 to 1912, inclusive.*

PRECIPITATION (INCHES).

Year.	Item.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1908		0.20	0.19	1.65	1.16	3.95	1.47	1.26	0.62	0.52	2.03	0.20	0.91	14.16
1909		.17	.23	.19	.84	3.87	5.59	2.45	.55	1.07	.76	.73	1.28	17.73
1910		.73	.70	.93	1.57	1.26	1.51	1.42	1.03	2.92	.27	.11	.10	12.55
1911		.13	.05	.09	.17	.45	.50	.80	1.86	.92	.39	.98	.30	6.64
1912		.24	.10	.71	2.32	2.26	.29	3.20	2.80	3.49	.51	.04	.13	16.09
	Average	.29	.25	.71	1.21	2.36	1.87	1.82	1.37	1.78	.79	.41	.54	13.43

EVAPORATION (INCHES).

Year.	Item.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1908		.....	.....	.....	5.53	5.92	6.82	8.08	7.87	6.75	.....	.....	.....	40.97
1909		.....	.....	.....	3.65	6.42	5.86	7.70	8.25	5.00	.....	.....	.....	36.88
1910		.....	.....	.....	5.41	5.31	8.98	10.42	7.30	4.31	.....	.....	.....	41.73
1911		.....	.....	.....	4.65	8.30	10.24	10.71	6.68	6.11	.....	.....	.....	46.69
1912		.....	.....	.....	4.85	6.42	8.18	7.98	6.60	3.71	.....	.....	.....	37.74
	Average	.....	.....	.....	4.81	6.47	8.01	8.97	7.34	5.17	.....	.....	.....	40.80

DAILY WIND VELOCITY (MILES PER HOUR).

Year.	Item.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1908	Mean	.....	.....	.....	.....	8.3	7.2	5.0	6.8	6.5	.....	.....	.....	.....
1909	do	.....	.....	.....	9.1	10.1	6.2	6.0	5.6	5.7	6.3	5.5	.....	.....
1910	do	.....	.....	6.3	9.2	8.2	9.3	7.7	6.6	6.2	7.1	6.5	9.2	.....
1911	do	7.5	5.8	9.6	9.2	11.6	9.1	7.9	7.3	7.7	.....	10.0	7.6	.....
1912	do	6.9	7.3	6.6	9.5	11.1	7.6	6.0	6.9	7.6	.....	.....	.....	.....
1908	Maximum	.....	.....	.....	.....	19.6	12.1	12.9	9.0	13.8	.....	.....	.....	.....
1909	do	.....	.....	.....	26.8	21.7	12.9	11.6	11.8	9.8	13.8	15.0	.....	.....
1910	do	.....	.....	18.9	23.8	22.0	19.4	17.6	17.6	12.1	18.3	16.7	28.0	.....
1911	do	18.8	14.4	19.6	18.6	19.4	20.7	19.4	15.3	15.9	.....	21.7	15.0	.....
1912	do	17.5	16.7	18.8	24.9	25.3	17.5	10.0	12.4	26.3	.....	.....	.....	.....
1908	Minimum	.....	.....	.....	.....	2.1	1.7	1.7	2.5	2.9	.....	.....	.....	.....
1909	do	.....	.....	.....	2.5	2.6	2.9	2.5	2.5	2.5	2.1	.9	.....	.....
1910	do	.....	.....	1.7	3.1	1.6	3.1	3.0	2.9	2.2	2.5	2.5	1.8	.....
1911	do	1.2	.8	2.4	3.3	3.9	4.5	2.8	2.6	2.5	.....	1.3	2.1	.....
1912	do	.8	2.1	1.3	3.0	2.9	2.8	3.0	2.1	1.5	.....	.....	.....	.....

TEMPERATURE (°F.).

Year.	Item.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1908	Monthly mean	.....	.....	.....	48	52	63	73	68	64	45	37	22	.....
1909	do	12	23	32	38	52	66	70	75	61	46	31	10	.....
1910	do	18	8	46	51	52	68	76	68	59	51	31	25	.....
1911	do	20	22	39	43	58	73	71	65	59	43	25	20	.....
1912	do	12	25	19	47	55	66	70	68	52	45	38	28	.....
1908	Monthly maximum	.....	.....	.....	89	79	90	100	101	105	82	75	49	.....
1909	do	50	51	65	73	84	95	100	105	96	84	73	49	.....
1910	do	45	46	87	89	81	108	109	101	97	91	67	52	.....
1911	do	59	61	78	88	90	101	105	100	94	82	58	51	.....
1912	do	44	49	70	78	84	101	94	95	94	85	70	57	.....
1908	Monthly minimum	.....	.....	.....	5	29	39	43	39	22	22	0	−12	.....
1909	do	−24	−19	12	6	22	45	41	45	31	11	− 7	−23	.....
1910	do	−19	−26	22	24	27	36	44	32	30	13	8	−13	.....
1911	do	−22	− 7	8	7	23	43	41	32	35	− 1	− 8	−25	.....
1912	do	−32	−12	−15	22	32	39	40	47	24	22	11	2	.....

KILLING FROSTS.

Season.	1908	1909	1910	1911	1912
Last spring frost	May 21	May 18	May 21	May 12	May 4
First fall frost	Sept. 27	Sept. 24	Sept. 26	Oct. 4	Sept. 25
Days free from frost	128	128	127	146	144

CONDITIONS ON THE PROJECT.

Weather conditions on the Belle Fourche Project in 1912 were generally favorable to the growth of irrigated crops. Hailstorms did some damage in restricted localities, particularly to a few small fields of sugar beets. One of the chief difficulties encountered was in getting the land properly graded and prepared for irrigation, as most of the farms were irrigated for the first time. The resulting inefficient irrigation probably had much to do with the low average yields obtained with many of the farm crops.

The total irrigable area of the farms on the Belle Fourche Project from which crop yields were reported in 1912 was 44,654 acres, included in 537 farms. Of this area 27,897 acres were actually irrigated. Harvests were reported from 24,617 acres; orchard trees were planted on 54 acres, and alfalfa was seeded but not harvested on 3,226 acres. The acreage, yields, and farm values of the crops produced on the project in 1912 are summarized in Table II. The figures were obtained from the United States Reclamation Service.

TABLE II.—*Acreage, yields, and farm values of crops on the Belle Fourche Project in 1912.*

Crop.	Area (acres).	Unit of yield.	Yield.			Farm value.			
			Total.	Per acre.		Per unit of yield.	Total.	Per acre.	
				Average.	Maximum.			Average.	Maximum.
Alfalfa hay	3,906	Tons	8,055	2.06	5.30	$5.00	$40,275	$10.31	$26.50
Barley	247	Bushels.	6,107	24.70	45.00	.50	3,053	12.35	22.50
Corn	1,830	...do	21,680	11.85	50.00	.50	10,840	5.93	25.00
Flax	261	...do	1,383	5.29	11.60	1.30	1,798	6.88	15.08
Native hay	3,009	Tons	1,788	.58	2.20	12.00	21,456	7.13	26.40
Oats	5,478	Bushels.	184,371	33.70	91.00	.35	64,530	11.75	31.85
Potatoes	357	...do	35,984	100.75	400.00	.40	14,394	40.25	160.00
Wheat	11,083	...do	194,756	17.57	37.50	.70	136,329	12.32	26.25
Miscellaneous	1,632						15,927	9.76	
Less duplications	3,186								
Total	24,617						308,602		
Average value per acre								12.54	

IRRIGATED ROTATIONS.[1]

During the spring of 1912 a series of 32 rotation experiments under irrigation was commenced. This series requires 86 plats of one-fourth of an acre each and includes the following crops: Alfalfa, sugar beets, clover, flax, oats, wheat, barley, corn, and potatoes (Fig. 2).

Swedish Select oats, Minnesota No. 169 wheat, Manchuria barley, Northwestern Dent corn, and Rural New Yorker potatoes were used in these experiments in 1912.

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[1] These experiments were under the immediate supervision of Mr. N. L. Mattice.

One plat is used for the continuous production of each crop for purposes of comparison with the regular rotations, which are as follows: Eleven 2-year rotations, four 4-year rotations, three 3-year rotations, and six 6-year rotations.

It will be several years before results of a conclusive nature can be obtained from the rotation experiments. Because of the fact that the land used was irrigated for the first time in 1912 there was much difficulty in properly leveling the land and applying the water, and the crop yields were consequently low. Table III shows the number of plats of each crop harvested in the rotation field in 1912, together with the average yield per acre of each crop.

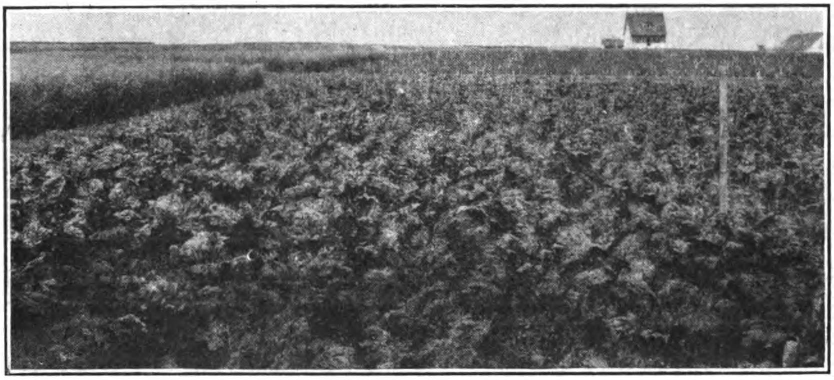

FIG. 2.—View in irrigated rotation field, showing plats of oats, flax, and sugar beets. Thirty-two different cropping systems are being tested in this field.

TABLE III.—*Number of plats and average yields per acre of crops in the irrigated rotation experiments on the Belle Fourche Project, 1912.*

Number of plats.	Crop.	Yield per acre.		Number of plats.	Crop.	Yield per acre.	
		Average.	Maximum.			Average.	Maximum.
15.....	Sugar beets[1]...tons..	7.60	10.40	11.....	Potatoes....bushels..	45.40	88.70
18.....	Oats........bushels..	51.90	80.00	7......	Corn............do....	28.60	37.00
1......	Barley..........do....	28.00	28.00	3......	Flax............do....	13.68	17.32
5......	Wheat..........do....	23.22	34.70	21.....	Alfalfa................	Clipped only; yield not determined.	

[1] Six samples of sugar beets from this field averaged 14.8 per cent sugar and 82 per cent purity. The average weight per beet on all 15 plats was 17 ounces.

TREE PLANTINGS.

The tree-planting experiments in cooperation with the Forest Service were started in the spring of 1909, when a tract of 3 acres above the ditch was planted to the following varieties: Cottonwood, white and golden willow, green ash (fig. 3), white elm, black locust, honey locust, Russian oleaster (fig. 4), Siberian pea tree, Black Hills spruce, red cedar, and Scotch pine. Conditions in the spring and summer of 1909 were very favorable to plant growth, and a good stand of all the varieties was secured. Of the deciduous trees, all varieties proved hardy except the black locust, which has winter-killed very badly.

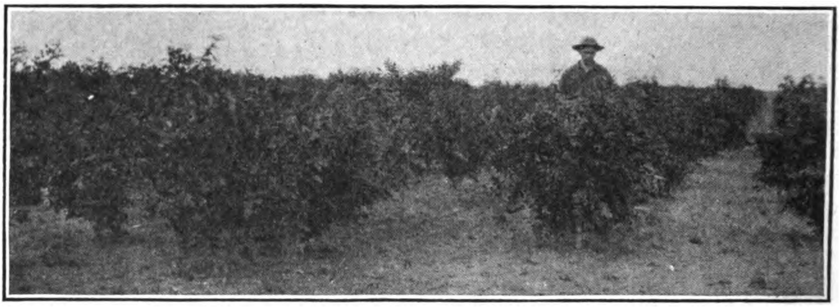

FIG. 3.—Green ash grown without irrigation, three years from seedlings. The green ash has proved very hardy and it is able to withstand severely dry weather. It is a valuable tree for both irrigated and dry land in western South Dakota.

The best varieties for dry land are Russian oleaster, green ash, white elm, and Siberian pea tree. While the other varieties are hardy, they require more water and appear to do well when irrigated. The varieties recommended for dry land would do still better where they could be irrigated. The evergreens have not done so well as the deciduous trees, and it is rather doubtful whether they can be grown with much success until they have some protection from other trees.

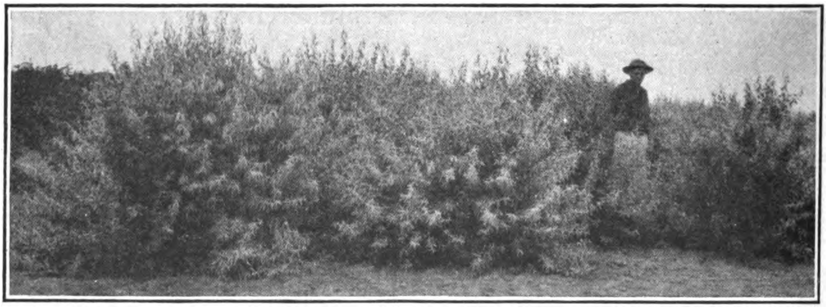

FIG. 4.—Russian oleaster grown without irrigation, three years from seedlings. The oleaster is winter hardy and withstands dry weather very well. It is particularly valuable for windbreaks and ornamental hedges.

In 1911 a bed of Scotch pine and Austrian pine was started, and a good stand was obtained. In 1912 these seedlings were transplanted to a frame covered by one-fourth shade. Nearly a perfect stand was secured, but the plants made very little growth. After another year these seedlings will be transplanted into the field. The main purpose of this experiment is to determine whether seedlings grown from seed in the locality will do better than seedlings shipped in. Some black walnuts were grown from seed and made a good growth, but, like the evergreens, they promise to do much better where they have some protection from older trees.

During the spring of 1912 a windbreak for the buildings and orchard was started. This is below the ditch and will be irrigated. When completed, this will consist of the following varieties: Cottonwood, white elm, green ash, Russian oleaster, Siberian pea tree, white willow, and possibly jack pine (*Pinus banksiana*). The arrangement of these varieties on the north and south is as follows: In the center there are eight rows of cottonwood, flanked on either side by six rows of alternate plantings of white elm, green ash, jack pine, Russian oleaster (two rows), and Siberian pea tree. On the south side there are four rows of white willows.

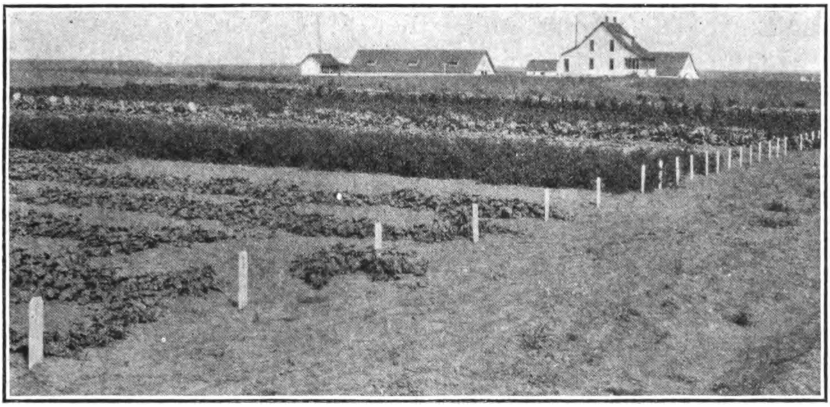

FIG. 5.—A view of the vegetable garden in early summer.

VEGETABLES.

The work with garden vegetables consists in growing a home garden well stocked with the ordinary vegetables used on the farm. (Fig. 5.) All the common vegetables of the northern latitudes do well on the project. It has been found advantageous at the experiment farm to irrigate and plow the land the fall before the garden is to be planted.

ORCHARD AND SMALL FRUITS.

Rather extensive tests of orchard trees and small fruits were started in the spring of 1912. Although water was not available until June 7, very nearly a month after the trees were planted, a stand of about

80 per cent was obtained. If it is impossible to have irrigation water early enough in the spring to soak up the land immediately after planting, it is desirable to irrigate as late as possible the fall before, so as to provide an abundance of moisture at the time of planting. No recommendations can yet be made as to varieties further than to indicate those which have proved most hardy on the older farms in western South Dakota under similar soil and climatic conditions. The following are the varieties under test at the experiment farm:[1]

Apples.—Oldenburg, Wealthy, Longfield, Northwestern, Kaump, Ben Davis, Yellow Transparent, Hibernal, Day, McIntosh, Peerless, Milwaukee, Plum Cider, Evelyn, and Anisim.

The first four varieties would probably be the best.

Crab apples.—Whitney, Florence, Red, Transcendent, and Hyslop.

Cherries.—Richmond, Suda, Montmorency Ordinaire, Ostheim, and English Morello (known locally as Wragg).

Plums.—Surprise, Ferry, Compass,[2] Wyant, Forest Garden, Wolf, De Soto, and Lombard.

Blackberries.—Snyder, Eldorado, Stone, Rathbun, and Briton.

Strawberries.—Warfield, Dunlap, Corsican, Haverland, Hathaway, Glen Mary, Aroma, and Crescent.

Currants.—Fay, Red Dutch, White Grape, Albert, London, and Perfection.

Gooseberries.—Downing, Pearl, Carrie, and Smith.

Considering the practical difficulties encountered in starting the tests of orchard trees and small fruits on the new land, the progress made was very satisfactory. Future work will include tests of methods of irrigation, tillage, cover crops, etc., with a view to securing information of practical value to the farmers on the project.

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[1] These varieties were selected upon the advice of Mr. H. P. Gould, of the Office of Field Investigations in Pomology.

[2] This is generally regarded as a hybrid between a sand cherry and a native plum.

A HAND GRAIN THRASHER.[1]

By **Lyman J. Briggs**, *Biophysicist in Charge of Biophysical Investigations.*

The simple hand thrasher shown in the accompanying illustration (fig. 1) has proved so useful in thrashing small quantities of grain in water-requirement investigations that a description of it may be of interest in connection with head-to-row experiments and similar investigations. As in other types of hand machines, the grain is thrashed by passing it between a rotating rubber-covered cylinder and a stationary apron. The novel features include means for adjusting the tension of the apron against the cylinder and a provision for the rapid cleaning of the machine.

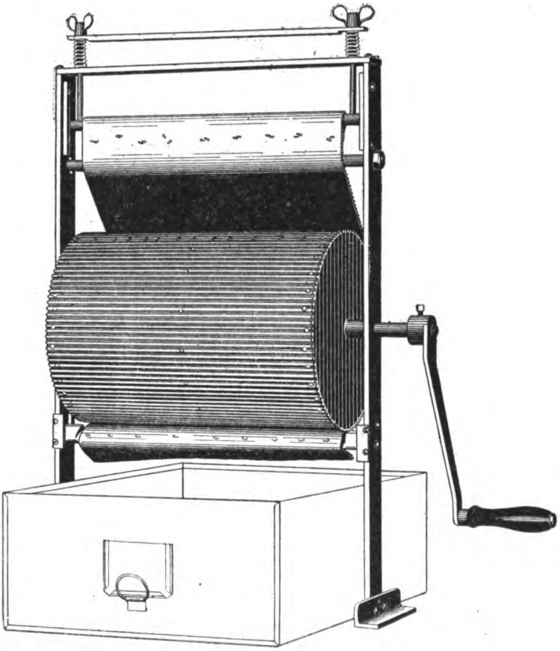

Fig. 1.—A hand grain thrasher.

The frame of the machine is built of steel, so as to give an open construction for convenience in cleaning, and is securely fastened to its table. The cylinder is built up from disks of wood 2 inches thick, glued together. The shaft is then forced into place and the cylinder turned true on its shaft. This wooden cylinder is then covered with a good quality of rubber matting, the corrugations being parallel to the axis. The matting is secured by tacks and staples and can easily be replaced when worn. The cylinder of the machine shown in figure 1 is 8 inches in diameter and 12 inches long. This will serve to give the approximate dimensions of the apparatus.

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[1] Issued Mar. 29, 1913.

An essential feature of the machine is the adjustable apron of rough canvas or similar material having an abrading surface. The apron is held against the cylinder by springs, the tension of which can be regulated by means of the wing nuts at the top of the machine. As the grain is fed into the machine the compression of these springs affords the necessary clearance between the cylinder and the apron.

A second convenient feature of the machine is the ease with which it can be cleaned. By pressing down on the upper crossbar, the rod supporting the lower end of the apron will slip out from between the guides, thus completely exposing both apron and cylinder to view.

ARABIAN ALFALFA.[1]

By ROLAND McKEE, *Scientific Assistant, Office of Forage-Crop Investigations.*

INTRODUCTION.

Arabian alfalfa is a very distinct variety. It was first introduced into the United States from Arabia in 1902 through the Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry, being received under S. P. I. No. 8806. The data here presented are based on experiments in the Southwest both with the original seed and later importations.

DESCRIPTION.

Arabian alfalfa is characterized mainly by its hairiness, large pale leaflets, soft hollow stems, soft crowns and roots, and quick recovery after cutting. It attains a height slightly less than that of ordinary alfalfa. The stems usually are quite erect and the plants of bushy habit. A whitish cast is given the herbage on account of the heavy pubescence. The crowns have but little tendency to spread and are high set and quite erect. There is little difference in the flowers as compared with ordinary alfalfa, the flowers of the Arabian variety being a trifle larger and of a slightly paler violet. The stems are not at all woody and the crowns and roots are very much softer than in ordinary alfalfa.

LIFE PERIOD.

Arabian alfalfa has a short life period. Grown under ordinary field conditions it will maintain a good stand for two years, but the third year the plants will be less vigorous and the stand not more than 80 per cent. In the fourth year the plants will be still weaker and the stand reduced to 50 per cent or less. When the plants are sown in wide rows and given cultivation they are more vigorous and live a year or two longer. While good cultural conditions make the growth of the Arabian variety more vigorous, its short life seems to be largely inherent.

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[1] Issued Mar. 29, 1913.

TEMPERATURE REQUIREMENTS.

Arabian alfalfa is not cold resistant and can be grown successfully only in sections having a mild winter climate. It can not stand zero weather without injury and can be grown successfully only in places where a temperature of 10° F. seldom or never occurs. It stands extremely high temperatures without injury, and only when soil moisture is lacking is it injured by heat. It is less drought resistant than ordinary alfalfa. While Arabian alfalfa is less hardy than others, it makes growth at a lower temperature than the more hardy types. During the mild weather of winter in the southwestern United States it makes considerable growth, while ordinary alfalfa and the more hardy varieties, such as the Turkestan and Grimm, make but little. On account of its ability to make growth in cool weather, Arabian alfalfa has a longer growing season than the ordinary or more hardy varieties. It is similar to the Peruvian alfalfa[1] in this respect.

LOSS OF MOISTURE AFTER CUTTING.

The rate of loss of moisture after cutting varies decidedly in different types of alfalfa. The Arabian variety loses its moisture much more rapidly after cutting than the Peruvian and ordinary alfalfa. In Table I the Arabian is compared first with the Peruvian and ordinary alfalfa (weight in grams) and afterwards with the Peruvian only (weight in pounds). These data cover the results of experiments at Chico, Cal., in 1911 and 1912. In both years the weighings were made on bright days in the month of June, the first weighing being made as quickly as possible after cutting. The moisture content of the Arabian, Peruvian, and ordinary alfalfa was found to be practically the same for all these varieties when cut at the same stage of maturity. When the plants are in vigorous growth they contain about 85 per cent of moisture if in the bud or first bloom and 75 to 80 per cent when one-tenth of the flowers are open. The loss of moisture in curing the Arabian variety is so much more rapid than in ordinary alfalfa that it must be handled more quickly in making hay in order to prevent undue loss of the leaves. The rapid loss of moisture in this variety is very noticeable to anyone handling it for hay. This character is in no way objectionable and would be an advantage in some places, as its rapid drying would render it possible to make it into hay with a shorter period of drying weather than would be the case with other varieties.

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[1] Brand, C. J. Peruvian alfalfa: A new long-season variety for the Southwest. U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 118, 1907.

TABLE I.—*Rate of loss of moisture after cutting in Arabian, Peruvian, and ordinary alfalfa at Chico, Cal., in 1911 and 1912.*

Variety.	Weights (grams) in 1911.						Weights (pounds) in 1911.						Weights (pounds) in June, 1912.				
	June 9.				Sept. 27.	Percentage of leaves by weight.	June 9.				June 12.	Aug. 8.					
	10.22 a. m.	11.52 a. m.	1.22 p. m.	4.00 p. m.			9.07 a. m.	11.00 a. m.	2.00 p. m.	4.00 p. m.			10.00 a. m.	11.00 a. m.	12.00 m.	2.00 p. m.	4.00 p. m.
Peruvian	400 400	279.0 263.5	221.0 203.5	181.7 164	86.4 80.1	50.6 54.4	100	78	48	42	24	22	100	83.5	65.5	31.5	24.5
Arabian	400 400	246 241.5	176 172.5	144.3 145.8	84.7 82.5	58.9 53.9	100	73	41	36	24	22	100	78.5	60.5	34.5	26
Ordinary Utah	400 400	273.5 265	211.5 200	177.3 174.4	80.3 84.7	52.6 47	....	....	....	....	....	....	....	....	....	....	....

NUMBER OF CUTTINGS PER SEASON.

Arabian alfalfa has the ability to recover quickly and to start growth again in a very short time after cutting. This tendency is very marked and makes it appear to grow much more rapidly than other varieties. The qualities of late-fall and early-spring growth and quick recovery after cutting enable one to get more cuttings per season of the Arabian variety than with ordinary alfalfa. At Mecca, Cal., as many as eleven cuttings of this variety have been made in a season when but eight of ordinary alfalfa were secured. At Chico, Cal., seven cuttings of the Arabian for hay and a heavy fall growth for pasturage have been obtained as against six cuttings of ordinary alfalfa. While one can secure more cuttings per season of this variety, there is not, as shown by experiments at Chico, a correspondingly larger yield of hay.

COMPARISON OF HAY YIELDS OF ALFALFA VARIETIES.

Arabian alfalfa has been grown at Chico, Cal., in comparison with Peruvian, Provence, Turkestan, and ordinary alfalfa to determine the comparative yields of hay. These data are given in Table II. The Arabian variety in comparison with these varieties produced in the first two years yields about equaling the ordinary alfalfa, but in the third and fourth years its yield was greatly reduced. The Peruvian variety in each of the four years tested produced more hay than the ordinary, Provence, or Arabian with which it was compared. The Provence variety has yielded about the same as the ordinary, while the Turkestan yielded considerably less. The Peruvian stands out prominently as the largest hay-yielding variety tested. The weights for the years 1906 to 1909 were taken each time as the hay was removed from the field in condition for the mow or stack. The weights in 1910, 1911, and 1912 were taken at the end of the season of each year, the hay of the different varieties having been stacked and allowed to become uniformly dry.

TABLE II.—*Hay yields (pounds per acre) of Arabian and other varieties of alfalfa grown in one-fourth acre plats at Chico, Cal.*

Comparison with Turkestan and other varieties.							Comparison with Peruvian and other varieties.					
S. P. I. No.	Variety.	1906	1907	1908	1909	Total for 4 years.	S. P. I. No.	Variety.	1910	1911	1912	Total for 3 years.
13999	Ordinary Utah..	10,315	22,128	18,574	18,226	69,243	23454	Ordinary..	4,376	13,012	13,596	30,984
14786	Turkestan.......	7,950	19,099	17,660	15,453	60,162	21195	Provence..	4,888	13,072	13,360	31,320
12694	Provence........	9,260	21,175	21,180	17,688	69,303	24430	Peruvian..	5,692	13,856	16,424	35,972
12992	Arabian.........	9,383	19,461	11,780	4,835	45,359	24367	Arabian...	5,448	13,076	7,864	26,388

At Mecca, Cal., an increased number of cuttings and a greater yield of the Arabian variety over the ordinary alfalfa were secured by the Brauckman Bros. in 1908. The data are given in Table III. It will be noted that by excluding the growth made during cool weather, when the ordinary alfalfa was practically dormant, the yield of the two varieties is more nearly the same.

TABLE III.—*Comparative hay yields of Arabian and ordinary alfalfa in plats 16 feet square, at Mecca, Cal., in 1908.*

Variety and date of cutting.	Weights (pounds).		Variety and date of cutting.	Weights (pounds).	
	Green.	Dry.		Green.	Dry.
Arabian:			Ordinary:		
May 12....................	66	16			
June 7....................	61	17	June 1....................	98	26
June 20....................	56	14	June 30....................	62	19
July 20....................	57	15	July 29....................	56	17
Aug. 6....................	53	15	Sept. 1....................	51	16
Sept. 1....................	40	13	Oct. 14....................	43	11
Sept. 14....................	30	10			
Oct. 14....................	41	10			
Total....................	404	110	Total....................	310	89

QUALITY OF HAY.

The hay made from Arabian alfalfa is paler than hay made from ordinary alfalfa. It is also less woody and contains a larger percentage of leaves. The feeding quality of the hay is good, and for cattle and sheep it apparently is equal or somewhat superior to ordinary alfalfa.

VALUE FOR PASTURAGE AND SOILING.

Arabian alfalfa will not stand as much trampling without injury as will the ordinary variety. This is because the crowns are more upright, higher set, and of a less woody texture. A firm low-spreading crown enables a plant to stand considerable trampling without injury and is desirable in a variety intended for pasture purposes.[1] Besides having a crown that will not stand trampling it has very soft roots that are readily eaten by stock which graze very closely or root into the soil, as do hogs. A good stand of Arabian alfalfa will be destroyed in one season if pastured by hogs and severely injured if pastured closely by any kind of stock.

On account of its upright habit, its ability to make quick recovery after cutting, and its ability to make growth in cool weather the Arabian variety in these respects is desirable for soiling purposes or cutting and feeding in the green state. However, on account of its short life period it should be used only when the crop is to stand for three years or less.

INJURY BY GOPHERS.

Gophers are a serious enemy of Arabian alfalfa. They are very fond of the soft succulent roots and do much more damage to this variety than to ordinary alfalfa. It has been found very difficult to maintain individual plants of the Arabian variety in rows on this account, and in plats sown broadcast considerable damage has been done.

SEED PRODUCTION.[2]

There is a great difference in varieties of alfalfa with regard to their seed-producing qualities. The Arabian variety produces less seed than ordinary alfalfa, and from the experience with it at Chico and other places in California it is quite evident that at best only about 100 pounds per acre can be produced. As the original home of Arabian alfalfa is in a country of very intense heat, it might be expected that hot weather would be conducive to seed setting in this variety, but experience has shown that it is injurious, causing blasting of the flowers. In the Imperial Valley of California, and at Mecca, Cal., where the summer heat is quite intense, the seed crops of the Arabian variety have been as light as at other places in that State. A better setting of seed has been secured in moderate rather than more intensive heat, so that somewhat early or late in the season the heat conditions are generally most favorable for a seed crop. However, as checking the plant growth, which is conducive to seed setting, can not be accomplished as easily in the spring as in the fall, the latter period is the more favorable. The production of seed of the Arabian variety on a commercial scale in the United States is not promising, but as this has not proved a very desirable variety and as the seed can be imported at a very reasonable price the demand can perhaps be supplied with imported seed. However, the supply in Arabia is very limited.

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[1] Oliver, George W. Some new alfalfa varieties for pastures, U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 258, 1913.

[2] For a complete discussion of the subject of alfalfa seed, see U. S. Department of Agriculture, Farmers' Bulletin 495, entitled "Alfalfa seed production."

SUMMARY AND CONCLUSIONS.

Arabian alfalfa was first introduced into the United States from Arabia in 1902.

This variety is not hardy to severe winter conditions and can be grown successfully only in sections having a very mild climate.

After cutting, the plants make new growth more quickly than any other variety.

The herbage loses moisture very rapidly after cutting and must be handled quickly in haymaking. The hay is of good quality.

In the first two years Arabian alfalfa makes a much heavier early-spring and late-fall growth than ordinary alfalfa.

More cuttings per season of this variety can be secured than with ordinary alfalfa, but the yield of hay is not correspondingly increased.

Arabian alfalfa produces about the same quantity or more hay the first two years than ordinary alfalfa, but less after the second year.

The seed production of this variety is very uncertain, and light crops only are secured.

The roots of Arabian alfalfa are very soft and gophers attack them in preference to other varieties.

The short-life period, normally but three years, is an inherent characteristic.

On account of its upright soft crown and soft roots Arabian alfalfa is severely injured by close pasturing or heavy trampling.

This variety can not be recommended for use except in a short rotation, and even then it should be used for soiling or hay purposes only.

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